YALMIP 工具箱使用说明

YALMIP 基于 MATLAB 符号工具箱编写，是一种定义和求解高级凸优化问题的语言，用于求解线性规划、整数规划、非线性规划、混合规划等标准化优化问题。另外，YALMIP 支持复变量运算，主函数为 solvesdp.m，函数调用简洁方便。

1.调用函数

定义决策变量	sdpvar()　　实型 intvar()　　整形 binvar()　　0-1 型
设定目标函数	f=目标函数
设定限定条件	F=set(限定条件)+set(限定条件)+···
调用函数 solvesdp	solvesdp(F,f)

注意事项：

1.1 默认 F 条件下求目标函数 f 的最小值，如需求最大值 f 前面加个负号即可；

1.2 求解之后查看数值，double(f) double(变量)；

1.3 为了更好的理解 YALMIP 工具箱，希望读者对 set.m、cone.m、sos.m、trace.m 等函数先有一定的理解；

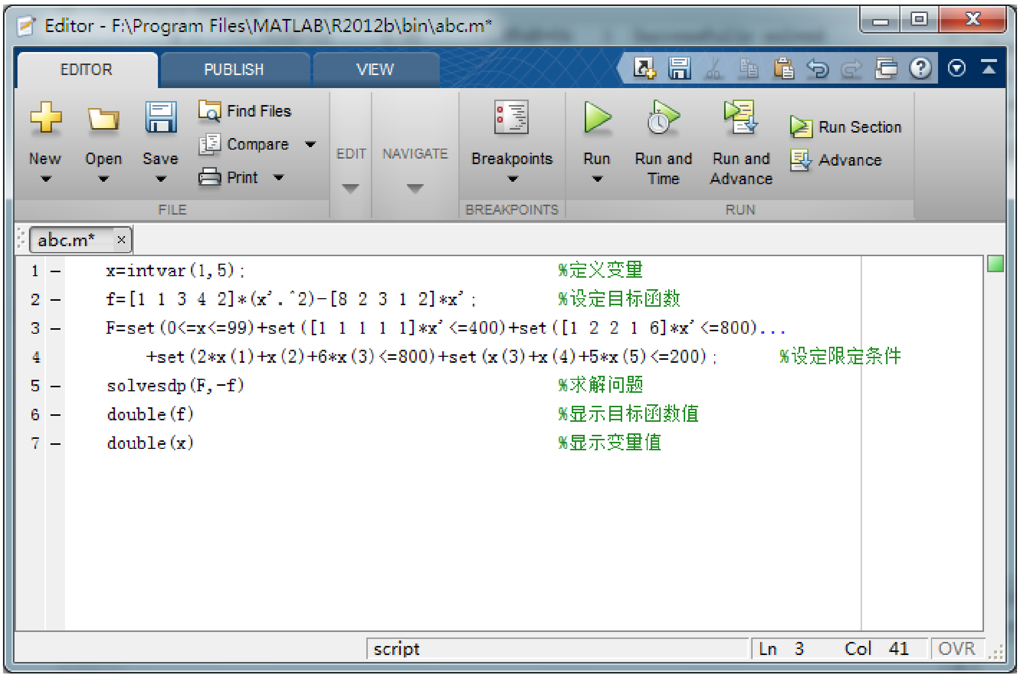
1.4 以上给出了求解非线性整数规划问题的实例分析，当变量定义、solvesdp(F,f)、限定条件等改变时，求解问题也相应改变；

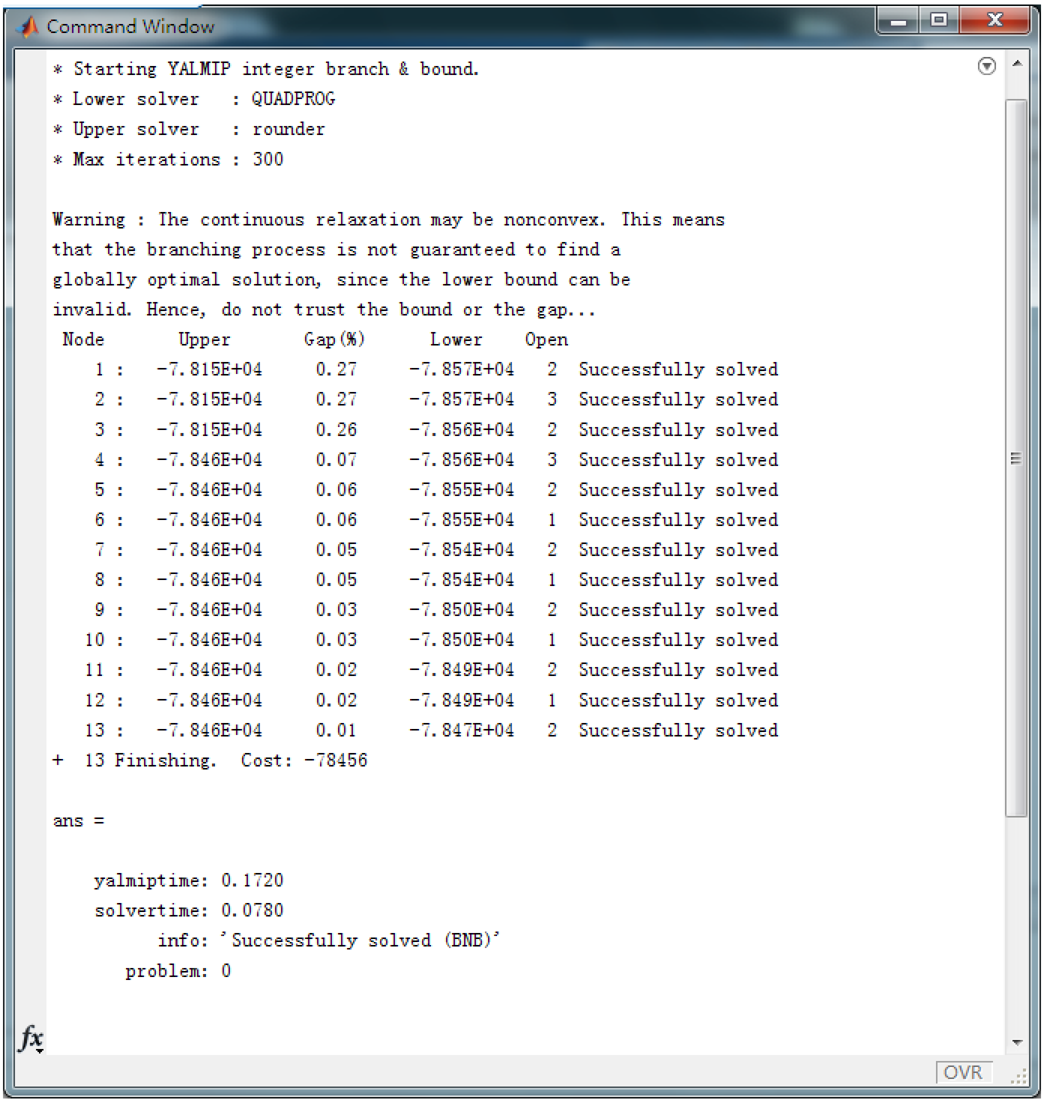
1.5 等式约束记作“==”；

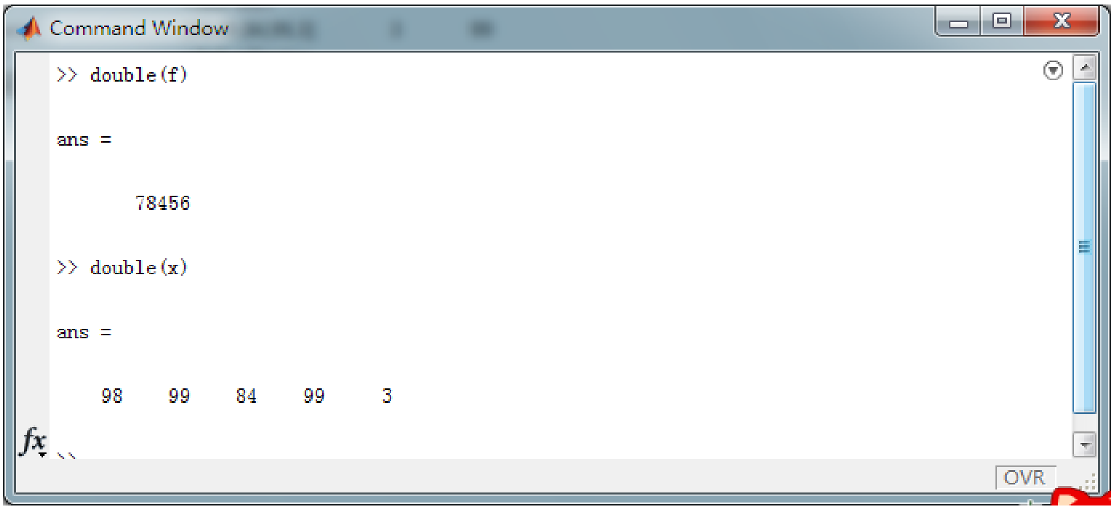
示例 1. 求解非线性整数规划问题

$$\max z = x_1^2 + x_2^2 + 3x_3^2 + 4x_4^2 - 8x_1 - 2x_2 - 3x_3 - x_4 - 2x_5$$

$$s.t.\begin{cases} x_1 + x_2 + x_3 + x_4 + x_5 <= 400 \\ x_1 + 2x_2 + 2x_3 + x_4 + 6x_5 <= 800 \\ 2x_1 + x_2 + 6x_3 <= 800 \\ x_3 + x_4 + 5x_5 <= 200 \\ 0 <= x_i <= 99 \end{cases}$$


Editor - F:\Program Files\MATLAB\R2012b\bin\abc.m*
EDITOR
PUBLISH
VIEW
New
Open
Save
Find Files
Compare
Print
FILE
EDIT
NAVIGATE
Breakpoints
BREAKPOINTS
Run
Run and Time
Run and Advance
Run Section
Advance
RUN
abc.m*
x=intvar(1,5);   %定义变量
f=[1 1 3 4 2]*(x'.^2)-[8 2 3 1 2]*x';   %设定目标函数
F=set(0<=x<=99)+set([1 1 1 1 1]*x'<=400)+set([1 2 2 1 6]*x'<=800)...
    +set(2*x(1)+x(2)+6*x(3)<=800)+set(x(3)+x(4)+5*x(5)<=200);   %设定限定条件
solvesdp(F,-f)   %求解问题
double(f)   %显示目标函数值
double(x)   %显示变量值
script
Ln 3
Col 41
OVR


Command Window
* Starting YALMIP integer branch & bound.
* Lower solver   : QUADPROG
* Upper solver   : rounder
* Max iterations : 300
Warning : The continuous relaxation may be nonconvex. This means
that the branching process is not guaranteed to find a
globally optimal solution, since the lower bound can be
invalid. Hence, do not trust the bound or the gap...
Node   Upper   Gap(%)   Lower   Open
1 : -7.815E+04   0.27   -7.857E+04   2 Successfully solved
2 : -7.815E+04   0.27   -7.857E+04   3 Successfully solved
3 : -7.815E+04   0.26   -7.856E+04   2 Successfully solved
4 : -7.846E+04   0.07   -7.856E+04   3 Successfully solved
5 : -7.846E+04   0.06   -7.855E+04   2 Successfully solved
6 : -7.846E+04   0.06   -7.855E+04   1 Successfully solved
7 : -7.846E+04   0.05   -7.854E+04   2 Successfully solved
8 : -7.846E+04   0.05   -7.854E+04   1 Successfully solved
9 : -7.846E+04   0.03   -7.850E+04   2 Successfully solved
10 : -7.846E+04   0.03   -7.850E+04   1 Successfully solved
11 : -7.846E+04   0.02   -7.849E+04   2 Successfully solved
12 : -7.846E+04   0.02   -7.849E+04   1 Successfully solved
13 : -7.846E+04   0.01   -7.847E+04   2 Successfully solved
+ 13 Finishing. Cost: -78456
ans =
yalmiptime: 0.1720
solvertime: 0.0780
info: 'Successfully solved (BNB)'
problem: 0
OVR



2. 用 YALMIP 解决与控制相关的问题分类

2.1 标准 SDP 问题

$$A^T P + PA \prec 0$$
$$P = P^T \succ 0$$

>>P=sdpvar(n,n);
>>F=set(P>0)+set(A'*P+P*A<0);
>>solvesdp(F)

2.2 行列式最大问题

$$\max_{Q,Y} \det Q$$
$$s.t. \begin{cases} A^T Q + QA + Y^T B^T + BY \preceq 0 \\ Q \succeq 0 \\ \begin{bmatrix} 1 & Y \\ Y^T & Q \end{bmatrix} \succeq 0 \end{cases}$$

```
>> Q = sdpvar(n,n);
>> Y = sdpvar(1,n);
>> F = set(Q>0);
>> F = F + set(A'*Q+Q*A+Y'*B'+B*Y < 0);
>> F = F + set([1 Y;Y' Q]>0);
>> solvesdp(F,-logdet(Q));
>> P = inv(double(Q));
>> L = P*double(Y);
```

2.3 大尺度 KYP-SDPs

$$\min_{t,P} \; t$$
$$\text{s.t.} \begin{bmatrix} A^T P + PA + C^T C & PB \\ B^T P & -tI \end{bmatrix} \preceq 0$$

```
>> P = sdpvar(n,n);
>> t = sdpvar(1,1);
>> M = blkdiag(C'*C,-t*eye(m));
>> F = set(kyp(A,B,P,M) < 0);
>> solvesdp(F,t,ops);
```

2.4 非凸半正定规划问题

$$(A+BKC)^T P + P(A+BKC) \prec 0, \; P = P^T \succ 0$$

```
>> P = sdpvar(n,n);
>> K = sdpvar(m,n);
>> Ac = A+B*K*C;
>> F = set(P > 0);
>> F = F + set(Ac'*P+P*Ac < 0);
>> solvesdp(F)
```

2.5 平方和问题

$$p(x) = 1 + x + x^4 = \begin{pmatrix} 1 \\ x \\ x^2 \end{pmatrix}^T \begin{pmatrix} 1 & 1/2 & -1/8 \\ 1/2 & 1/4 & 0 \\ -1/8 & 0 & 1 \end{pmatrix} \begin{pmatrix} 1 \\ x \\ x^2 \end{pmatrix}$$

```
>> x = sdpvar(1,1);
>> p = 1+x+x^4;
>> F = set(sos(p));
>> solvesos(F)
```

2.6 多参数规划问题

$$\begin{aligned} z^*(x) = \arg\min_z \quad & \tfrac{1}{2} z^T H z + (c + Fx)^T z + d^T x \\ Gz \quad & \leq \quad w + Ex \end{aligned}$$